

EXHIBIT A



MEMORANDUM

To: Mr. Keith Johnson, NWR Cleanup Manager
Mr. Dana Bayuk, DEQ Project Manager

From: James G.D. Peale, RG

Date: June 10, 2015
Project: 8128.01.20

Re: Source Area CVOC Reduction Progress Report—Siltronic (ECSE 183)

The following is a progress update for the in situ chemical reduction (ISCR) enhanced bioremediation (EIB) at the Siltronic site, as it relates to active chlorinated volatile organic compound (CVOC) remediation in the source area. The objective of this document is provide a brief technical summary for communications between and among the members of the DEQ Northwest Region Cleanup and Site Assessment Section Team.

In summary, the analysis of monitoring results confirm:

- Successful attainment of the remedial action objective (RAO) at all of the source area monitoring wells
- Trichloroethene (TCE) mass reduction of 99.88 percent and an overall CVOC mass reduction of 93.93 percent
- Sustained attainment of the USEPA maximum contaminant level for TCE in all but two of the monitoring wells

The ISCR-EIB pilot study injection program was completed in 2006, with subsequent monitoring in four wells. Larger-scale ISCR-EIB injections began in January 2009 and were completed in June 2009. Source area monitoring included an additional 20 wells from November 2008 through the present. Supplemental injections, upgradient of the 2009 injections, were completed in 2011, with monitoring continuing in four more wells.

This report reviews the analysis of the monitoring data and presents the conclusions related to the ongoing performance of EIB, including mass removal estimates and performance toward achieving the RAO (i.e., TCE concentrations below 11,000 micrograms per liter [ug/L]). The information herein will also be incorporated into the revised remedial investigation report in order to more accurately reflect site CVOC conditions, which have improved significantly since 2007.

MASS REMOVAL ESTIMATES USING EVS

Data from the monitoring wells are regularly modeled with Environmental Visualization System[®] (EVS) software for estimating the mass of TCE and its degradation products in the source area, using standard 3D kriging statistical techniques. The result of this analysis is presented as a time-series plot of the aggregate source area CVOC mass in groundwater. Figure 1 (below) shows that the TCE mass was rapidly reduced, and the degradation product, (cis)dichloroethylene (cDCE), initially increased as expected (which is the reason for a temporary increase in the total CVOC mass). The cDCE mass decreased after July 2009. Vinyl chloride (VC) was also produced as expected, but at significantly lower concentrations. VC production peaked in February 2012 and then decreased.

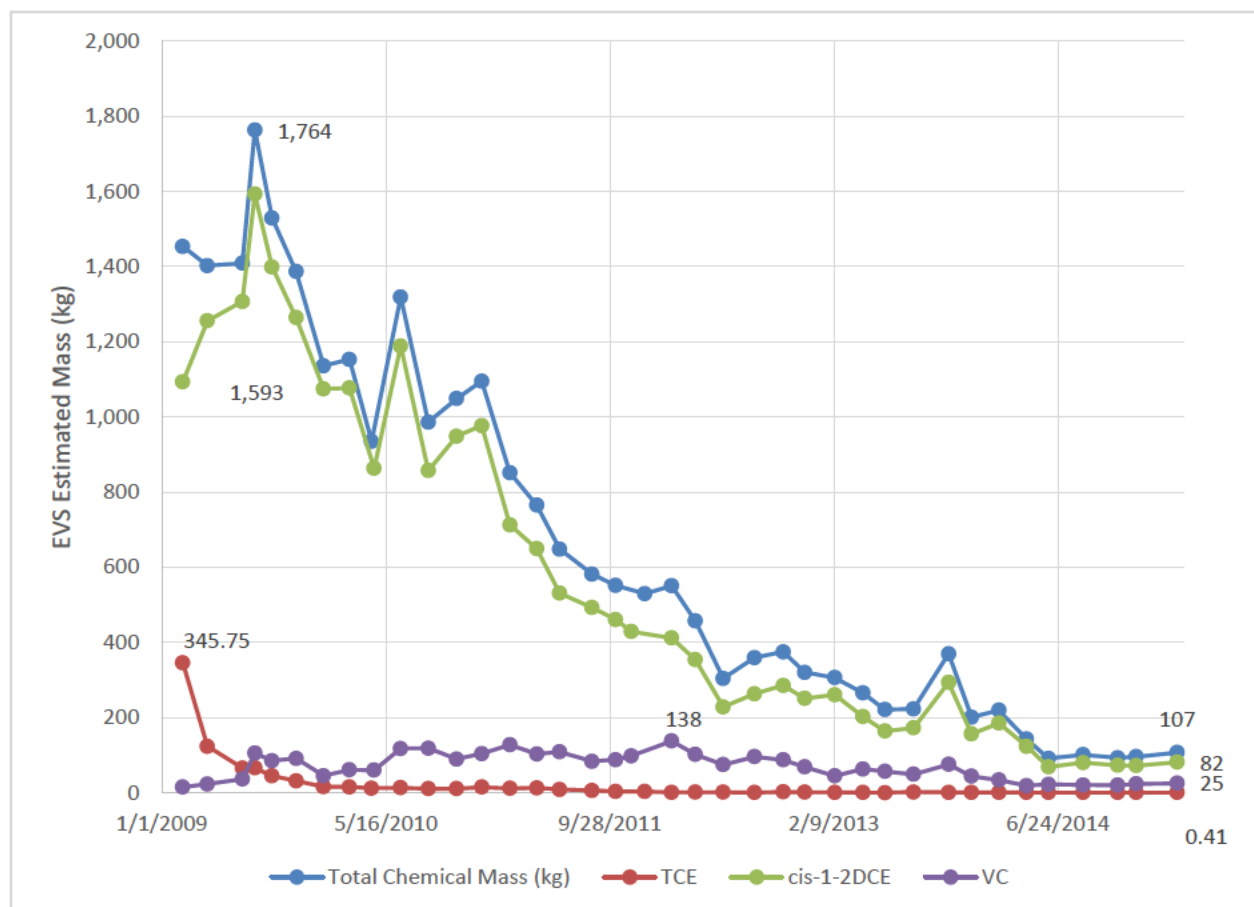


Figure 1—EVS Estimated Mass of CVOCs in the Source Area. Maximum and most recent data points (used for calculations in Table 1) are labeled.

The mass removal information is also summarized in Table 1, and confirms that relative to the initial or maximum estimated mass values, ISCR-EIB has removed more than 99 percent of the source TCE and more than 93 percent of the total CVOCs.

Table 1—Mass Removal Statistics. Mass reduction was calculated using the most recent data values compared to the initial (TCE) or subsequent maximum data values.

	Sum CVOCs	TCE	cDCE	VC
Initial or Max Estimated Mass (kg)	1763.7	345.8	1592.7	137.7
Mass Reduction (kg)	1656.7	345.3	1511.2	112.6
% Mass Reduction	93.93%	99.88%	94.88%	81.76%
NOTE: kg = kilogram(s).				

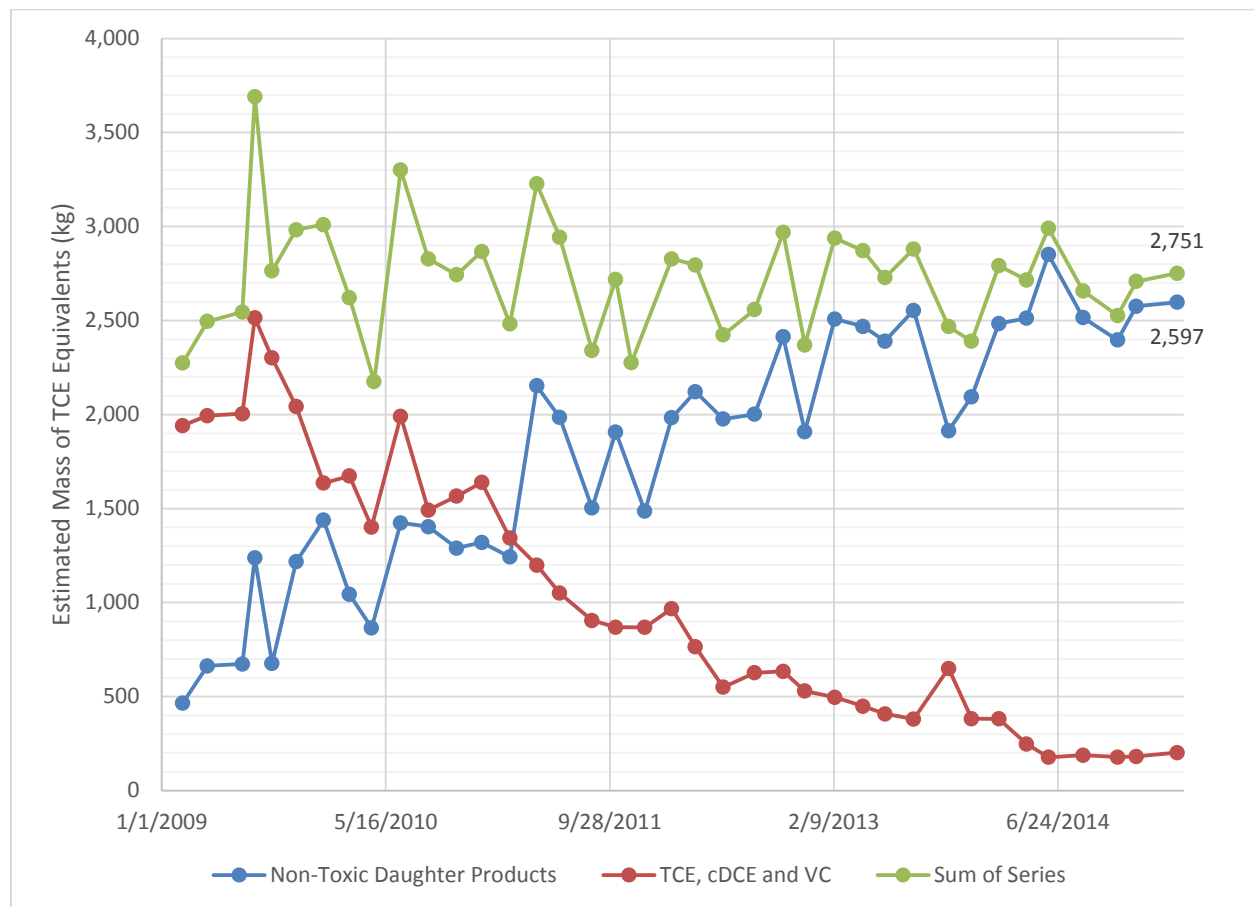


Figure 2—Estimated Mass of TCE Equivalents from Non-Toxic Daughter Products and CVOCs

Another view of the data confirms the ongoing conversion of CVOCs to ethene and chloride. Figure 2 shows the estimated mass for three data sets:

- 1) The total estimated mass of CVOCs (TCE, cDCE, and VC)¹

¹ To account for stoichiometric generation of daughter products, EVS-generated mass estimates of all species were converted to molar data to calculate equivalent moles of TCE as the parent material; and the equivalent moles were

- 2) The estimated mass of the terminal, nontoxic degradation products, primarily chloride but also ethene
- 3) The sum of the first two series to demonstrate nearly complete conversion

This figure shows that the significant reduction of the chlorinated VOCs results in the continued generation of nontoxic chloride and ethene, which currently comprise approximately 94 percent of the total estimated mass of parent and daughter products. The sum of the series fluctuates but stays fairly constant (between 2,500 and 3,000 kg), confirming the mass balance of the degrading CVOCs vs. the stable chloride concentrations.

PERFORMANCE RELATIVE TO RAOs

RAO 1 for the source area is to reduce TCE concentrations in all wells to below the threshold indicative of the presence of TCE dense nonaqueous-phase liquid (DNAPL) (i.e., 11,000 ug/L in groundwater). Three wells were selected to evaluate the timeframe for reaching the RAO. These wells are described below:

- WS-13-69 was installed immediately below the former TCE underground storage tank system, with sustained TCE concentrations considered indicative of residual TCE DNAPL. This well was monitored following completion of the initial injection program. All of the remaining wells monitored in the source area following the initial injection program reached the RAO before WS-13-69. The RAO was attained in this well eight months following injection.
- WS-41-91 was installed deeper than and upgradient of WS-13-69 to monitor performance following the supplemental injection program in 2011. The RAO was attained in this well within seven months after injection.
- WS-43-36 was installed in the fill zone and represents an area of manufactured gas plant (MGP) waste DNAPL with entrained TCE DNAPL. Concentrations of TCE in groundwater from this well reflect ongoing desorption of TCE from the MGP/TCE DNAPL mixture, but have remained below the RAO since the end of 2013. The RAO was attained in this well 25 months following injection.

The data in Table 2 confirm that ISCR-EIB was extremely effective for rapidly reducing TCE concentrations to levels well below the RAO, mostly within months following completion of the injection programs. ISCR-EIB was also effective for achieving the RAO in spite of the presence of the MGP-TCE DNAPL mixture in the well and the subsurface. In the wells not discussed in this memo, TCE concentrations either are non-detect or are less than 14 ug/L as of the most recent monitoring event.

then converted back to estimated mass of TCE equivalents. The sum of TCE, cDCE, and VC as TCE equivalents shown on Figure 2 is therefore greater than the estimated mass of TCE, cDCE, and VC measured in groundwater as shown on Figure 1.

Table 2—RAO Performance

Well	Date Monitoring Started	Date of Max TCE	Max TCE (ug/L)	Date RAO 1 Met	Current TCE (ug/L)
WS-13-69	04/13/2009	09/03/2009	122,000	12/16/2009	3.36
WS-41-91	04/05/2011	06/20/2011	90,800	11/15/2011	2.78
WS-43-36	04/26/2011	11/29/2011	83,800	12/03/2013	6,160

SUMMARY

Based on monitoring well data and the EVS-generated mass estimates, ISCR-EIB has significantly reduced the CVOC source area mass and continues to be effective at reducing the mass of residual degradation products. Data from the individual wells confirm that ISCR-EIB was effective for achieving RAO 1 for this area, often within months following injection. These results demonstrate that the Siltronic bioremediation project is significantly reducing CVOCs as expected.

These data confirm successful in situ remediation of a chlorinated solvent DNAPL source at an active manufacturing facility, and reflect a significant and groundbreaking technical accomplishment on the part of Siltronic and the DEQ technical staff.

EXHIBIT B



Environmental Performance Awards and Recognition

Siltronic Corporation is an environmental leader in the industry and in the community as demonstrated by our environmental performance and awards including:

- 2015 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2014 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2012 Sustainability At Work Award (Silver): City of Portland
- 2012 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2011 Ten Year Award: Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2010 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2010 Siltronic grants a conservation easement for the "River Plan" Restoration Project.
- 2010 Oregon DEQ Certificate of Appreciation to Myron Burr for contributions to Oregon's Toxics Criteria Rulemaking Workgroup
- 2010 Letter of appreciation for support of the Columbia River Estuary Partnership.
- 2010 City of Portland Recycle at Work Certification for Siltronic's continued commitment to recycling.
- 2010 Letter of appreciation for donation of clean-room suits.
- 2009-2011 ISO 14001:2004 SGS Certificate.
- 2009 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2009 City of Portland Recycle at Work Certification for improved recycling practices.
- 2008 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.



- 2007 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2007 *Environmental Protection* magazine's 2007 Facility of the Year Award (one of five facilities)
- 2007 EPA National Environmental Performance Track Large Facility Annual Award for exemplary environmental performance.
- 2007 State of Oregon Sustainability Focus Award for commitment to sustainable business practices.
- 2006 Five Year Award: Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations
- 2006 Environmental Leadership and Support of Renewable Power from Portland General Electric.
- 2005 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2004 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2004 Oregon Governor Kulongoski recognized achievement in reducing nitrate discharges to the Willamette River.
- 2003 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2003 Associated Oregon Industries Environmental Excellence Award to Tom McCue, Siltronic Corporation Environmental Manager.
- 2002 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2002 Distinguished Member of Business Recycling Awards Group which is among the elite 1% of regional businesses for waste prevention and recycling (City of Portland).
- 2000 Environmental Excellence Award from the City of Portland for perfect performance of wastewater pretreatment operations.
- 2000 Certification and Registration of Environmental Management System which complies with the requirements of ISO 14001.
- 2000 Charter Member, U. S. EPA National Environmental Achievement Program – for commitment to sound environmental management, continuous improvement, and sustained environmental compliance.
- 2000 Pollution Prevention Award for habitat restoration of wetland areas in partnership with City of Portland, Bureau of Environmental Services, Children's Arboretum project.



- 1999 Environmental Excellence Award from the City of Portland for no pretreatment violations.
- 1997 Environmental Excellence Award from a supplier for leadership in the use of energy efficient equipment and environmentally responsible products.
- 1997 Portland General Electric Power Smart Award for energy efficient design and operation.
- 1997 Portland BEST Business Award. Best overall success for energy efficiency, water conservation, Waste Reduction (recycling), clean and efficient transportation alternatives.
- 1997 Founding Member of Oregon Natural Step Network.
- 1996 Pollution Control Award for pollution prevention partnership with state and local environmental agencies to pilot pollution prevention programs and to demonstrate their success.
- 1996 first Evergreen Award from the EPA for pollution prevention through voluntary efforts.
- 1994 Certificate of Appreciation from the US EPA for participation in the Industrial Toxics Program.
- 1993 Environmental Excellence Award from the City of Portland demonstrating leadership in water quality.
- 1991 Oregon Governor's Award for Toxics Use Reduction achievements in waste and use reduction.

EXHIBIT C

State of Oregon
Department of Environmental Quality

Memorandum

To: Matt McClincy, VCS Project Manager

Date: February 23, 2004

From: Dave Wall, HW Inspector

Subject: Wacker Siltronic Question: Should the contaminated soil and ground water at the 7200 SW Front site be listed as an F002 waste?

EPA ID #ORD096253737

This memo is in response to your request to Andree Pollock for the Hazardous Waste Section to review Wacker Siltronic's determination that TCE contamination in soil and groundwater should not be characterized as F002 waste.

Andree asked me to investigate this matter. My investigation found that the TCE contamination at the Wacker site originated from spent solvent that was used for polishing and dewatering during wafer manufacturing processes at the Wacker facility addressed above. I found that it is likely that the TCE escaped from Wacker's solvent recycling system. Once the TCE escaped from the solvent recycling system it became a waste.

The original TCE concentrations fluctuated from approximately pure TCE (95%) to a recycled purity of about 25% TCE. 40 CFR 261.31 states that TCE is listed as an F002 waste because of its hazardous characteristics. EPA further states that this material cannot lose this listing because it became diluted in soil, water, or through other means. EPA's F002 listing states that any F002 listed material that originally contained more than 10% pure product must retain the F002 listing.

EPA's FAXBACK 14291 as it relates to the "Contained in Policy" states that EPA generally considers contaminated environmental media (soil, groundwater, etc.) to contain hazardous waste if the media exhibit a characteristic of hazardous waste. Wacker's analysis of the groundwater and soil shows that TCE is present.

Wacker's argument that they do not know where the contamination comes from, given their process and use of TCE since the early 1980's is not compelling. It is likely that the TCE contamination originated from one of many sources listed in Wacker's documentation.

Wacker's characterization of the TCE contamination as either a D040 or a non-contaminant because they think it may have leaked from a recycling holding tank that contained trace amounts of TCE is not valid according to EPA rule.

The results of my investigation of this matter determined that the contaminated soils and ground water at the Wacker site listed above must be considered F002 listed wastes.



EXHIBIT D



Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved, OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST		1. Generator ID Number O R D 0 9 6 2 5 3 7 3 7	2. Page 1 of 2	3. Emergency Response Phone (877) 818-0087	4. Manifest Tracking Number 000966600 VES			
5. Generator's Name and Mailing Address SILTRONIC/PROJECT 7200 NW FRONT AVE MAILBOX 50 ATTN: K LAIL PORTLAND, OR 97210 Generator's Phone: 503 501-5218		Generator's Site Address (if different than mailing address) SAME						
6. Transporter 1 Company Name VEOLIA ES TECHNICAL SOLUTIONS		U.S. EPA ID Number N J D 0 8 8 6 3 1 3 6 9						
7. Transporter 2 Company Name SAVANNAH TRANSPORT		U.S. EPA ID Number K S 0 0 0 0 3 3 6 8 9 1						
8. Designated Facility Name and Site Address VEOLIA ES TECHNICAL SOLUTIONS HIGHWAY 73 3.5 MILES W. OF TAYLOR'S BAYOU PORT ARTHUR, TX 77640 Facility's Phone: 409 736-2821		U.S. EPA ID Number T X D 0 0 0 8 3 8 8 9 6						
9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))		10. Containers No. Type		11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes	
	X	1. NA3082, HAZARDOUS WASTE, LIQUID, n.o.s., (VINYL CHLORIDE, TRICHLOROETHENE), 9, III	10	T P	22000	P	F002 D040 D043 F037 OUTS101H	
		2.						
		3.						
		4.						
14. Special Handling Instructions and Additional Information ER Service Contracted by VESTS -/- 1) ERG:171 W:71087 PTA071087								
15. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governments' regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent. I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (c) (if I am a small quantity generator) is true.								
Generator's/Officer's Printed/Typed Name Karen Cole		Signature <i>Karen Cole</i>		Month Day Year 10/2/05/15				
16. International Shipments <input type="checkbox"/> Import to U.S. Transporter signature (for exports only)		<input type="checkbox"/> Export from U.S. Port of entry/exit Date leaving U.S.						
17. Transporter Acknowledgment of Receipt of Materials Transporter 1 Printed/Typed Name Karen Simmonds		Signature <i>Karen Simmonds</i>		Month Day Year 10/2/05/15				
Transporter 2 Printed/Typed Name		Signature		Month Day Year				
18. Discrepancy 18a. Discrepancy Indication Space <input type="checkbox"/> Quantity <input type="checkbox"/> Type <input type="checkbox"/> Residue <input type="checkbox"/> Partial Rejection <input type="checkbox"/> Full Rejection Manifest Reference Number								
18b. Alternate Facility (or Generator) Facility's Phone		U.S. EPA ID Number						
18c. Signature of Alternate Facility (or Generator)		Month Day Year						
19. Hazardous Waste Report Management Method Codes (for codes for hazardous waste treatment, disposal, and recycling systems)								
1.		2.		3.		4.		
20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in item 18a. Printed/Typed Name Signature Month Day Year								

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Exhibit D 000001



Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved, OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST		1. Generator ID Number ORD 096253737	2. Page 1 of 1	3. Emergency Response Phone (877) 816-0087	4. Manifest Tracking Number 000966602 VES			
5. Generator's Name and Mailing Address SILTRONIC/PROJECT 7300 NW FRONT AVE MAILBOX 50 ATTN: K LAIL PORTLAND, OR 97210		Generator's Site Address (if different than mailing address) SAME						
6. Generator's Phone 503 501-5218		U.S. EPA ID Number N J D 0 8 0 6 3 1 3 6 9						
7. Transporter 1 Company Name VEOLIA ES TECHNICAL SOLUTIONS		U.S. EPA ID Number K S 0 0 0 3 3 6 8 9 1						
8. Designated Facility Name and Site Address VEOLIA ES TECHNICAL SOLUTIONS, L.L.C. 9131 EAST 96TH AVE. HENDERSON, CO 80640		U.S. EPA ID Number C O D 9 8 0 5 9 1 1 8 4						
Facility's Phone 303 289-4927								
GENERATOR	9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No. Type		11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes	
	X	1. NA3077, HAZARDOUS WASTE, SOLID, n.o.s. (TRICHLOROETHYLENE, BENZENE), 9, III, RQ (F002)	3	D M	1200	P	F002 F037	
		2.						
		3.						
		4.						
14. Special Handling Instructions and Additional Information BR Service Contracted by VESTS -I- 1) BRG:171 W:541996								
15. GENERATOR'S/SHIPPER'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent. I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.								
Generator's/Shipper's Printed/Typed Name Koreen Lail		Signature <i>Koreen Lail</i>		Month Day Year 05 05 15				
TRANSPORTER INTL	16. International Shipments <input type="checkbox"/> Import to U.S. <input type="checkbox"/> Export from U.S.		Port of entry/exit: Date leaving U.S.:					
	Transporter signature (for export only): Aaron Simmonds		Signature <i>Aaron Simmonds</i>		Month Day Year 05 05 15			
DESIGNATED FACILITY	17. Transporter Acknowledgment of Receipt of Materials Transporter 1 Printed/Typed Name Aaron Simmonds		Signature <i>Aaron Simmonds</i>		Month Day Year 05 05 15			
	Transporter 2 Printed/Typed Name		Signature		Month Day Year			
	18. Discrepancy							
	18a. Discrepancy Indication Space <input type="checkbox"/> Quantity <input type="checkbox"/> Type <input type="checkbox"/> Residue <input type="checkbox"/> Partial Rejection <input type="checkbox"/> Full Rejection							
	18b. Alternate Facility (or Generator) Facility's Phone		Manifest Reference Number		U.S. EPA ID Number			
18c. Signature of Alternate Facility (or Generator)				Month Day Year				
19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)								
1.		2.		3.		4.		
20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in item 18a								
Printed/Typed Name		Signature		Month Day Year				

EPA Form 8700-22 (Rev. 3-05; Previous editions are obsolete.)

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Exhibit D 000002

EXHIBIT E



Davis Rothwell

EARLE & XÓCHIHUAC

Ilene Munk Gaekwad
ATTORNEY IN OREGON, KANSAS & MISSOURI
igaekwad@davisrothwell.com

U.S. BANCORP TOWER
111 SW Fifth Ave, Suite 2700, Portland, OR 97204
T (503) 222-4422 F (503) 222-4428
Offices in Portland & Seattle

January 27, 2016

Ms Lori Cora
Assistant Regional Counsel
EPA Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

**Re: Trillium Inc. Report Regarding Historical Activities at
Portland Gas & Coke from a Chemical Production Perspective**

Dear Lori:

Attached you will find a report prepared by Drs. Smith and Hadka of Trillium Inc. (Trillium). Trillium reviewed the documents we sent to EPA and DEQ on December 11, 2015, that included significant documentation from publicly available sources related to the operations at Portland Gas and Coke (PG&C), a predecessor of Northwest Natural from 1913 through 1958.

The experts at Trillium have been in the business of reviewing analytical data from manufactured gas plants and other Superfund Sites for many years. As a result of their respective areas of expertise (which can be gleaned from their attached *curriculum vitae*), they understand the manufactured gas plant process and other chemical manufacturing processes.

As you will see from their report, the activities at PG&C were "unique," with nearly half of those activities completely uninvolved in or required for the manufacture of gas. Importantly, the Coking ovens in use at PG&C from 1941 and thereafter, were operated specifically to produce electrode coke for the aluminum industry, and not manufactured gas. Manufactured gas was a byproduct of the coking process cleverly used to heat the coking ovens, with overflow amounts of gas occasionally sent to the gas plant.

The Trillium report discusses the types of wastes generated from the activities at PG&C and may inform EPA's decision with regard to the characterization of these wastes. This report will be part of the next 104(e) update Siltronic submits to EPA and our response to NWN's letter of January 22, 2016, but we did not want to delay in providing this information to you and DEQ.

Sincerely,



Ilene M. Gackwad

IMG/gmt

Attachment

Email transmission

cc: Mr. Dana Bayuk
Myron Burr, PE
Ms. Patricia M. Dost
Mr. Keith Johnson
James G.D. Peale, RG, LHG
Mr. Christopher L. Reive



TRILLIUM INC.

Consultants in Environmental Chemistry

520 PECK ROAD
DOWNTOWN, PA 19335

(610) 873-2691

FAX (610) 873-2692

EMAIL mhadka@trilliuminc.com

www.trilliuminc.com

January 21, 2016

Ilene M. Gaekwad, Esquire
Davis Rothwell Earle & Xóchihua P.C.
111 Southwest Fifth Avenue, Suite 2700
Portland, Oregon 97204-3650

Re: Portland Gas and Coke Plant, Linnton, Oregon

Dear Ms. Gaekwad:

Here is our expert report. We agree with James Peale's map of the Portland Gas and Coke (PG&C) Plant in Linnton, Oregon that his outline in red (see attached) is the portion of the plant that was used for gas manufacture. The areas of the property that are not outlined in red were used for PG&C's chemical business. The primary standard industrial classification (SIC) code that would apply to the PG&C Linnton Plant is 4925, Mixed, Manufactured, or Liquefied Petroleum Gas Production. SIC code 4925 includes "manufactured gas production and distribution," "coke oven gas, production and distribution," and "coke ovens, by-product: operated for manufacture or distribution of."¹ The light oil refinery is under SIC code 2865, Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments which includes "aromatic chemicals, such as benzene, toluene, mixed xylenes [and] naphthalene" and "creosote oil, made in chemical plants."² The briquette production and coke ovens are included in SIC code 2999, Products of Petroleum and Coal, Not Elsewhere Classified which includes "fuel briquettes or boulets, made with petroleum binder" and "coke, petroleum: not produced in petroleum refineries."³ Also SIC code 3312 Steel Works, Blast Furnaces (Including Coke Ovens),

¹ https://www.osha.gov/pls/imis/sicsearch.html?p_sic=3312&p_search=

² Ibid. Note SIC code 2865 includes "coal tar distillates," "pitch, product of coal tar distillation" and "tar, product of coal tar distillation," however, products from the oil tar are not listed.

³ Ibid.

HOME OFFICE

28 GRACE'S DRIVE • COATESVILLE, PA 19320 • (610) 383-7233 • FAX (610) 383-7907

OFFICES IN:

DELAWARE • LOUISIANA • MARYLAND • PENNSYLVANIA • TENNESSEE



and Rolling Mills includes "distillates, derived from chemical recovery from coke ovens."⁴

Objective

Characterize the operations that were performed at the PG&C Plant in Linnton, Oregon and determine the types of wastes generated and the disposal of these wastes.

Facts

PG&C opened the Linnton, Oregon Gas Plant in 1913 on the banks of the Willamette River to manufacture gas and chemicals.⁵ The gas plant received heavy fuel oil (i.e. cracked and straight-run residuum oil similar to a heavy #6 Fuel oil/ Bunker C) from refineries in California and converted the oil into manufactured gas and chemicals. Manufacture gas plants (MGPs) using only petroleum oil as the fuel to manufacture the gas are known as oil-gas plants. Only about 7 to 8 % of the manufactured gas in the 1920's was made from oil with a majority of the manufactured gas in the United States made from coal.⁶

The PG&C Linnton Plant operated as a MGP between 1913 and 1958.⁷ The MGP made gas for illumination and for heating. The rest of it was waste. Production at the PG&C Linnton gas plant stopped in April 1958.⁸ In 1965 the plant was leased to Koppers Company to manufacture carbon pitch and creosote at a new coal tar facility Koppers plans to build at the site.⁹ In 1972 Northwest Natural (formally Portland Gas and Coke) announced the construction of a new substitute natural gas plant in Linnton.¹⁰

PG&C built and operated separate chemical manufacturing facilities on the property adjoining the Linnton MGP. The chemical manufacturing facilities included a light oil refinery, a tar distillation plant, a lampblack processing plant (Briquet Plant), and coke ovens that produced a variety chemicals that were an important source of income to PG&C. Their first chemical product produced in 1913 was briquettes which were manufactured in the lampblack processing plant. The briquettes were sold as domestic fuel.¹¹ In 1923 the light oil recovery and refinery was built to process the light oil into

⁴ Ibid.

⁵ Kohlhoff, W. A. and W. H. Hull, *Oil Gas Manufacture*, Industrial and Engineering Chemistry, May, 1952 (44), pp 936-948.

⁶ Ibid. Kohlhoff and Hull.

⁷ Ibid. Kohlhoff and Hull and *GASCO Runs Off Last Batch of Oil, Plans to Close Byproducts Business*, The Oregonian, April 22, 1958.

⁸ *GASCO Runs Off Last Batch of Oil, Plans to Close Byproducts Business*, The Oregonian, April 22, 1958.

⁹ *Firm Signs Site Lease*, The Oregonian, August 26, 1965.

¹⁰ *Substitute Natural Gas Plant To Open*, The Oregonian, October 2, 1972.

¹¹ Ibid. Kohlhoff and Hull.



aromatic chemicals such as benzene (benzol),^{12,13} toluene, xylenes and solvent naphtha.¹⁴ A tar plant distilled and processed tar into soft and hard pitch,¹⁵ road tars, crude naphthalene, and creosote.¹⁶ Creosote was not initially recovered until after 1941.^{17,18} Creosote was used as a wood preservative (e.g. wooden railroad ties and utility poles) and contains hazardous chemicals such as polynuclear aromatic hydrocarbons (PAHs). Creosote when discarded is classified as a RCRA hazardous waste, waste code U051 (40CFR 261). The first road tars were sold in 1925.¹⁹ Four oil coking ovens were installed in 1941 to produce electrode coke,²⁰ increase the "relative yields of liquid residuals" and to produce a higher BTU gas.²¹ In 1941, PG&C constructed a new "basic chemical plant" next to the gas plant at Linnton which is described as "The first of its type in the gas industry and the only one west of St. Louis".²² Sulfur removed during the gas purification process was made into powdered elemental sulfur and sold as an insecticide and fungicide.²³ Naphthalene recovered from the light oil refinery was sold under contract to a local seed company as a "soil repellent for such pests as wire worms,

¹² The "EPA has classified benzene as known human carcinogen for all routes of exposure" (<http://www3.epa.gov/ttn/atw/hlthef/benzene.html>).

¹³ Benzol was sold as a motor fuel (*New Motor Fuel On Local Market*, *The Oregonian*, November 4, 1923) and during World War II was sold to make synthetic rubber (*Waste From Wood of Northwest's Forests Destined to Keep The Family Car Running*, *The Oregonian*, July 30, 1944).

¹⁴ Ibid. Kohlhoff and Hull and Hall, E. L., *Aromatics, Gas, and Coke from Heavy Petroleum Residues*, *Chemical & Metallurgical Engineering*, September, 1941.

¹⁵ Pitch is defined by *Webster's New World College Dictionary* (4th ed.) as "a black, sticky substances formed in the distillation of coal tar, wood tar, petroleum, etc. and used for waterproofing, roofing, pavements, etc." The density of creosote is heavier than water and. The pitch produced by Portland Gas and Coke was used as a binder to hold the carbon electrode together that were used in the smelting of aluminum. In 1952 Portland Gas and Coke was supplying 30,000 tons of electrode pitch to the nearby aluminum industry (Kohlhoff and Hull).

¹⁶ Creosote is an oil obtained from the distillation of wood-tar, coal-tar, or oil-tar (i.e. Portland Gas and Coke Plant). Besides selling creosote as a wood preservative PG&C used a light creosote fraction as the wash oil in scrubbers after the gas generator to remove the light oils containing benzene, toluene, xylenes, and solvent naphtha from the gas generated (Kohlhoff and Hull). The use of creosote is currently restricted by the U.S Environmental Protection Agency (USEPA) to certified wood-preservation facilities and the creosote preserved wood cannot be used for residential use or contact with food or drinking water (<http://www.epa.gov/ingredients-used-pesticide-products/creosote>). Creosote has a density greater than water and will sink below the water table when released into the environment.

¹⁷ "Not initially recovered but available for future production annually will be 3,000,000 gal. of creosote oil..." Hall, E. L., *Aromatics, Gas, and Coke from Heavy Petroleum Residues*, *Chemical & Metallurgical Engineering*, September, 1941.

¹⁸ According to Figure 3 and 4 in Kohlhoff and Hull, the creosote was from the oil coke plant built in 1941.

¹⁹ Ibid. Kohlhoff and Hull.

²⁰ Used to make electrodes for smelting aluminum. The need for coke to produce electrodes grew as the aluminum industry increased in the Pacific Northwest (Kohlhoff and Hull).

²¹ Ibid. Kohlhoff and Hull.

²² *Gas Company To Add Plant*, *The Oregonian*, April 3, 1941.

²³ *\$1,000,000 By-Products Recovered in Gas Making*, *The Oregonian*, February 22, 1939.



maggots, etc."²⁴ In 1957, the plant was upgraded to produce a higher grade of benzene and toluene.²⁵

The processes used by PG&C were similar to coal tar distillation plants processes found at coke furnaces and at manufactured gas plants using coal.^{26,27}

The four oil coking ovens installed in 1941 produced coke for the manufacture of electrodes for the growing aluminum industry in the Pacific Northwest.²⁸ In the coking process the same heavy fuel oil as used in the gas ovens is fed into the heated coke oven in the absence of air. The heating of oil or coal in the absence of air is called "pyrolysis" or "destructive distillation".²⁹ At the end of the coking cycle the doors of the oven are opened and the red hot coke is pushed by a horizontal ram into the quenching car (similar to railroad gondola car). The quenching car quickly travels on tracks to the quenching station where water is sprayed on the coke. The vapors collected from the coke oven are separated into tar, light creosote, and light oil which are sent to the refinery for processing into products. Gas recovered as a by-product from the coking ovens was combined with the gas produced by the MGP.

There were approximately 3,000 to 5,000 former manufactured gas plants in the United States.³⁰ Generally these plants only produced and sold gas and did not produce other products.^{31,32} The PG&C gas plant "is unusual in that it simultaneously produces chemical co-products of gasification that account for 35% of the total operating income."³³ This was accomplished by adding a refinery, a tar distillation plant, a lampblack/briquet processing plant and coke ovens as separate operating units. A map of the PG&C facility shows that the footprint of the refinery, tar distillation plant, lampblack/briquet processing plant and coke ovens were greater than that of the gas plant including the residual fuel oil storage tanks.³⁴ The revenues produced from the sale of chemical products was an important source of income to PG&C. The sale of chemicals was a profitable part of the company's operation generating net profits of over nine

²⁴ *Report on Portland Gas and Coke Company*, prepared by EBASCO Services, Inc. and Portland Gas and Coke Company, August 1939, p. 21.

²⁵ *Firm Gets Oil Facility*, *The Oregonian*, March 3, 1957.

²⁶ Warnes, A. R., *Coal Tar Distillation and Working Up of Tar Products*, John Allan and Company, London, 1913.

²⁷ Harkins, S. M., R. S. Truesdale, R. Hill, P. Hoffman, and S. Winters, EPA600/2-88/012, *US Production of Manufactured Gases: Assessment of Past Disposal Practices*, February 1988.

²⁸ *Ibid.* Kohlhoff and Hull.

²⁹ Cook, G. A., *Survey of Modern Industry Chemistry*, Ann Arbor Science, 1977. The production of petroleum coke in the United States is relatively small compared to coke from coal.

³⁰ Mauro, D., *Chemical Source Attribution at Former MGP Sites*, EPRI 1000728, December 2000.

³¹ *Ibid.* EPA600/2-88/012.

³² Emsbo-Mattingly, S., et. al., *Sediments Guidance Compendium*, EPRI 1005216, October 2001.

³³ *Ibid.* Kohlhoff and Hull.

³⁴ GASCO Works Tract Tax Lot 42, May 8, 1931 and last revised January 22, 1948.



million dollars between 1913 and 1938.³⁵ While net revenues from the sale of gas increased by 160% between 1941 and 1951, the net revenues from the sale of chemicals increased 500% during the same period.³⁶ In 1951, gross revenues from the sale of chemicals were \$4,433,516 out of \$11,106,954 operating revenue.³⁷ Thus in 1952, the sale of these chemicals were approximately 40% of the gross revenues for PG&C.

Aerial photos between 1940 and 1966 of the PG&C site show multiple above ground storage tanks and distillation towers that would be associated with chemical processing/refinery. Aerial photos dated 4/1952, 7/1952, 1956, 5/1957, 3/1961, 4/1961, 6/14/1963, 9/23/1964, and 8/11/1966 show evidence of a holding pond east-southeast of the plant. The 7/1952 photograph show this pond contains a liquid based on the reflection of the trees on the surface of the liquid. A mound of material can be seen adjacent to this pond in several of the photographs including 4/1952, 5/1957, 3/1961, 4/1961, 9/23/1964, and 10/10/1966. Several of the photographs show what appear to be a mound of material northwest of the oxide purifier yard which corresponds to the location labeled "spent oxide storage on a map of the facility."³⁸ The photographs (i.e. 4/1961) also show a black stained area running from the Briquet Storage Shed to the river. This area corresponds to the lampblack storage area on the map of the facility. By the time of the 8/29/1968 photograph there is some reduction in the number of buildings and storage tanks that are present on the facility.

A. Wastes Generated by Portland Gas and Coke's Linnton Plant

The depiction of the gas and chemicals operation and the wastes generated by the PG&C Plant in Linnton is described in two literature references written by employees of the gas plant. The first reference was published in 1941 by E. L. Hall, Vice-President and Chief Engineer for PG&C.³⁹ The second reference was published in 1952 by W. A. Kohlhoff and W. H. Hull.⁴⁰ Mr. Kohlhoff was also Chief Engineer for the gas company. Both references describe similar processes and wastes generated with minor changes between 1941 and 1952. Information on the gas plant's process and wastes are also shown in a Flow Diagram dated November 16, 1940. The waste streams described in these references are:

³⁵ *Report on Portland Gas and Coke Company*, prepared by EBASCO Services, Inc. and Portland Gas and Coke Company, August 1939, p. 22.

³⁶ PS&C 1951 Annual Report.

³⁷ *New High Set in Byproducts*, The Oregonian, March 27, 1952. Gross revenue from by-products increased \$597,342 and operating revenues by \$966,899 from the 1950 revenues.

³⁸ GASCO Works Tract Tax Lot 42, May 8, 1931 and last revised January 22, 1948.

³⁹ Hall, E. L., *Aromatics, Gas, and Coke from Heavy Petroleum Residues*, Chemical & Metallurgical Engineering, September, 1941.

⁴⁰ Kohlhoff, W. A. and W. H. Hull, *Oil Gas Manufacture*, Industrial and Engineering Chemistry, May, 1952 (44), pp 936-948.



Wash Box Wastewater

The gases from the gas generator were passed through a wash box containing water where lampblack was deposited in the water. The water containing 1% to 2% lampblack from the wash box was transferred to lampblack processing equipment where water was separated from the lampblack in several steps. The first step in the process was the "Dorr Thickener" where the water removed from the lampblack was discharged as wastewater most probably to the river or a holding pond.⁴¹ This wastewater being in contact with the gases from the gas generator will contain dissolved and entrained material generated by the gas generator such as benzene, phenols, and thiophene. The solubility⁴² of benzene, phenol and thiophene in water is 1,800, 82,000, and 3,600 parts per million (ppm) respectively.⁴³

Tar Processing

The tar/water emulsion collected from the tar scrubbers⁴⁴ is processed to separate the tar from the water. Secondary catch boxes are shown in Figure 2 of Kohlhoff and Hull with an overflow that is discharged to a settling basin. The settling basin was used to remove settleable matter from wastewater. At the time the gas plant was built the settling basin(s) were probably an earthen structure. The overflow material discharged to the catch basin would have contained a tar/water emulsion. This tar/water emulsion (see footnote 44) would contain benzene, toluene, xylenes, polynuclear aromatic hydrocarbons (PAHs), and other material that could seep into the soil contaminating both the soil and groundwater with the tar materials and because tar is heavier than water can go beneath the groundwater.

Steam was circulated in a closed system within the tar dehydrators to evaporate the remaining water in the tar. The condensed steam from the tar dehydrators was discharge to the plant's sewer lines⁴⁵ which probably was went into the river or a holding pond (see footnote 41).

⁴¹ Figure 2 in Kohlhoff and Hull shows "clear effluent to sewer" coming from Dorr Thickener. However, the plant was not connected to the public sewer until 1974 (City of Portland Department of Public Works, Permit No. 95080, April 2, 1974). The sewer in Figure 2 of Kohlhoff and Hull was most likely a plant sewer that discharged to the river or to a holding pond.

⁴² This is the maximum amount of a pure substance that can dissolve in water at approximately room temperature with no more of the pure substance able to dissolve.

⁴³ Verschuere, Karel, Handbook of Environmental Data on Organic Chemicals, 2nd Edition, Van Nostrand Reinhold Company, 1983. The solubilities of benzene, phenol and thiophene measured at 20, 15 and 15°C, respectively.

⁴⁴ The tar scrubbers removed the tar from the gas stream using water which formed an emulsion with the tar. An emulsion is a mixture of insoluble material and water that is difficult to separate similar to oil and vinegar.

⁴⁵ Figure 2, Kohlhoff and Hull.



Sulfuric Acid Wash Waste

Figure 4 in Kohlhoff and Hull, Figure 2 in Hall, and the November 16, 1940 Products Flow Diagram show an acid agitator device to process the once run light oil.⁴⁶ This process was part of PG&C's chemical plant that refined light oil into aromatic chemicals. According to Hall's Figure 2, sulfuric acid was added to the acid agitator to treat the light oil. Sulfuric acid was used in the tar industry to remove undesirable chemicals from the light oil.⁴⁷ These undesirable chemicals include thiophene, olefins, naphthalene, phenols, nitrogen containing aromatics (i.e. pyridine⁴⁸) and amines.⁴⁹ The acid agitator is used to thoroughly mix the light oil with the sulfuric acid. After the agitation stops, light oil separates from acid which contains the impurities. The acid layer known as "acid tar" is drawn off⁵⁰ and the light oil layer is removed for further processing. The acid tar drawn off from the acid agitator is shown in the November 16, 1940 Products Flow Diagram and in Hall's Figure 2 with an arrow going from the acid agitator and pointing to "sludge to waste." Thus, the acid tar was disposed as a waste probably to an earthen basin on-site. There was little use for the acid tar.^{51,52} According to Wilsnack and Lunak "It is usually neutralized with lime and allowed to sink into the ground."⁵³

The acid tar waste would have contained the materials removed from the light oil by the sulfuric acid clean-up. The reactions with sulfuric acid includes the "oxidation and/or removal of sulfur compounds, the removal of nitrogen bases into the acid, the polymerization of unsaturated organic compounds, the sulfonation of aromatic compounds, the oxidation of unstable hydrocarbons and the polymerization of certain aromatic hydrocarbons."⁵⁴ This material removed by the acid includes thiophenes,

⁴⁶ Once run light oil is the light oil produced from the first distillation step by the light oil still.

⁴⁷ Warnes, A. R., Coal Tar Distillation and Working Up of Tar Products, John Allan and Company, London, 1913.

⁴⁸ Ibid. Warnes, p. 90.

⁴⁹ Wilsnack, G. C. and S. E. Lunak, Distillation of Coal Tar, American Institute of Technology, 1908.

⁵⁰ Ibid. Wilsnack, G. C. and S. E. Lunak. After acid is removed, the light oil was probably washed several times with water and dilute sodium hydroxide to neutralize any acid in the light oil.

⁵¹ Ibid. According to Wilsnack, G. C. and S. E. Lunak, "Many attempts have been made to utilize the acid tar even without profit, but as yet no satisfactory treatment seems to have been discovered."

⁵² Some of the sulfonated material may have been later used to help break the tar emulsion in the tar emulsion storage tank according to the 1952 paper by Kohlhoff and Hull. However, the earlier paper by Hull published in 1941 and the November 16, 1940 Products Flow Diagram indicate the acid tar was a waste. Thus, from 1913 when the gas plant was built until sometime in the 1940's or early 1950's the acid tar was disposed as a waste.

⁵³ Ibid. Wilsnack, G. C. and S. E. Lunak.

⁵⁴ Ibid. EPA600/2-88/012, p. 104.



olefins, naphthalenes, and phenols along with amines⁵⁵ and aromatics.⁵⁶ The sulfonated compounds are more soluble in water than the original compound. The heterocyclic compounds⁵⁷ are subject to oxidation creating more toxic compounds.⁵⁸ According to Wilsnack and Lunak, "The acid tar causes a great deal of trouble to tar distillers killing as it does all fish in rivers and perceived at great distances by its stench."⁵⁹ Thus, prior to the Linnton plant being built, the toxicity of acid tar was well known by the tar distillation industry.

Oxide Purifiers

The gas generated at the plant is passed through a mixture of iron oxide and wet wood shavings to remove the hydrogen sulfide and hydrogen cyanide from the manufactured gas. A small amount of air (2-3%) was added to the gas flow to regenerate the iron oxide.⁶⁰ After the iron reached 40% sulfur, it was discarded as a waste.⁶¹ By 1939, over 50,000 tons of this spent oxide had accumulated at the plant site since the gas plant first started operations in 1913.⁶² In the manufactured gas industry the spent oxides were usually disposed as a fill material around the plant, at a dump or on private property.⁶³ However, the oxide waste may catch on fire if exposed to air and disposal of this waste at many public dumps was prohibited. "Consequently, spent iron oxide wastes are a major waste material remaining on and around manufacturing sites of manufactured gas."⁶⁴ A plant to precipitate finely divided sulfur was built in 1935 to use the sulfur as an insecticide and fungicide which was distributed by Chipman Chemical Company.⁶⁵

⁵⁵ Nitrogen bases such as amines are generally absent in acid tar produced from oil-gas. Ibid. EPA600/2-88/012, p. 104.

⁵⁶ Ibid. EPA600/2-88/012, p. 104.

⁵⁷ Contains oxygen, sulfur or nitrogen.

⁵⁸ Lemkau, K. L., A. M. McKenna, D. C. Podgorski, R. P. Rodgers, and C. M. Reddy, *Molecular Evidence of Heavy-Oil Weathering Following the M/V Cosco Busan Spill: Insights from Fourier Transform Ion Cyclotron Resonance Mass Spectrometry*, *Environmental Science and Technology*, 2014, 48, pp. 3760-3767.

⁵⁹ Ibid. Wilsnack, G. C. and S. E. Luna.

⁶⁰ Ibid. Wilsnack, G. C. and S. E. Luna.

⁶¹ *Report on Portland Gas and Coke Company*, prepared by EBASCO Services, Inc. and Portland Gas and Coke Company, August 1939, p. 21.

⁶² Ibid. EBASCO.

⁶³ Ibid. EPA600/2-88/012, p. 144.

⁶⁴ Ibid. EPA600/2-88/012, p. 145.

⁶⁵ ⁶⁵ *Report on Portland Gas and Coke Company*, prepared by EBASCO Services, Inc. and Portland Gas and Coke Company, August 1939, pp. 21-22.



Discussion and Opinion

- A. Comparing the Portland Gas and Coke Plant at Linnton, Oregon to other manufactured gas plants (MGPs) in the United States, the Portland Gas and Coke Plant was a unique operation. First, the PG&C Plant manufactured gas from fuel oil and not from coal used in other MGPs.⁶⁶ According to Kohlhoff, and Hull, only about 7 to 8 % of the manufactured gas in the 1920s used the oil-gas procedure. Second, the PG&C Plant included a chemical plant that produced lampblack, tar products, and aromatics such as benzene that were sold for different uses.
- B. Waste materials have been generated by the Portland Gas and Coke Plant at Linnton since the plant was first opened in 1913. Although the PG&C Plant produced and sold many chemicals, however, many of the chemicals were not produced until after 1923 when the light oil refinery was built and road tar was not sold until 1925. Creosote was not recovered until after 1941. Creosote contains PAHs such as anthracene and chrysene, heterocyclic compounds containing oxygen, sulfur and nitrogen such as dibenzofuran, and carbazole and phenols.^{67,68} Thus, this material would be waste to the plant and would have to be disposed. The United States Environmental Protection Agency considers discarded creosote as a Resource Conservation and Recovery Act (RCRA) hazardous waste, waste code U051.⁶⁹ After the light oil recovery and refinery chemical plant was built in 1923, acid tar waste was produced and had to be disposed. Acid tar waste was a black tar like material which included sulfonated aromatics such as naphthalenes and heterocyclic compounds containing nitrogen, sulfur, and oxygen such as thiophenes, phenols, and polymeric olefins. Portland Gas and Coke Plant also disposed of spent iron oxide from the oxide purifiers that contained iron oxide, wood chips, ferric and ferrous sulfides, elemental sulfur, iron cyanides, thiocyanates, volatile organics, and tars.⁷⁰ In addition, overflow effluent from the tar process was disposed in a settling basin and wastewater was also generated that had to be disposed.
- C. The wastes generated by the Portland Gas and Coke Plant at Linnton were disposed in settling basins at the site as documented in Figure 2 in Kohlhoff and Hull. These basins were used to dispose of the overflow effluent from the secondary catch boxes from tar processing. Similar basins were probably used to

⁶⁶ "Chemical Source Attribution at Former MGP Sites," EPRI 100728, December, 2000. The three major MGP processes were Coal Carbonization (CC), Carburetted Water Gas (CWG), and Oil Gas.

⁶⁷ Ibid. EPA600/2-88/012, p. 103.

⁶⁸ MSDS, KMG-Bernuth, Inc., P1 Creosote Oil, August 26, 2011.

⁶⁹ 40CFR 261.22.

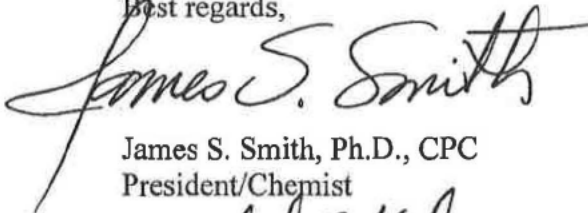
⁷⁰ Ibid. EPA600/2-88/012, p. 145.



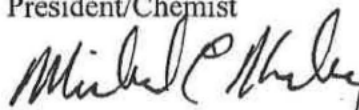
dispose of the acid tar. A common practice in the manufactured gas industry was to fill a trench dug in the ground with the acid tar and burn the waste, however, only a portion of the waste would burn leaving the residue in the ground.⁷¹ Other wastes that were produced prior to the 1923 were probably disposed in basins at the site. These basins were usually made from an earthen material that allowed the waste to sink into the ground. In general, waste material from MGP plants were often disposed on-site in trenches and in holding ponds.^{72,73} The specific gravity of wastes such as creosote (1.03-1.18)⁷⁴ and tars (1.2-1.3)⁷⁵ designates the waste as a dense non-aqueous phase liquid (DNAPL) that will sink below the water table. The soil and groundwater at these former MGP sites are contaminated by waste material from past waste disposal practices at these MGP sites. In addition to the waste material "leakage and spills of scrubbing oils, or distilled light oils, could create local areas of contamination at gas plants."⁷⁶

If you have any questions, please let us know.

Best regards,



James S. Smith, Ph.D., CPC
President/Chemist



Michael C. Hadka, Ph.D.
Chemist

MCH/mch
Enclosure

⁷¹ Ibid. EPA600/2-88/012, p. 141.

⁷² Ibid. EPRI 100728

⁷³ Ibid. EPA600/2-88/012.

⁷⁴ MSDS: Koppers Inc., Coal Tar Creosote, March 27, 2015 and KMG-Bernuth, Inc., P1 Creosote Oil, August 26, 2011.

⁷⁵ Ibid. EPA600/2-88/012, Table 33, Comparison of Some Pacific Coast Oil-Gas Tars.

⁷⁶ Ibid. EPA600/2-88/012, p. 135.

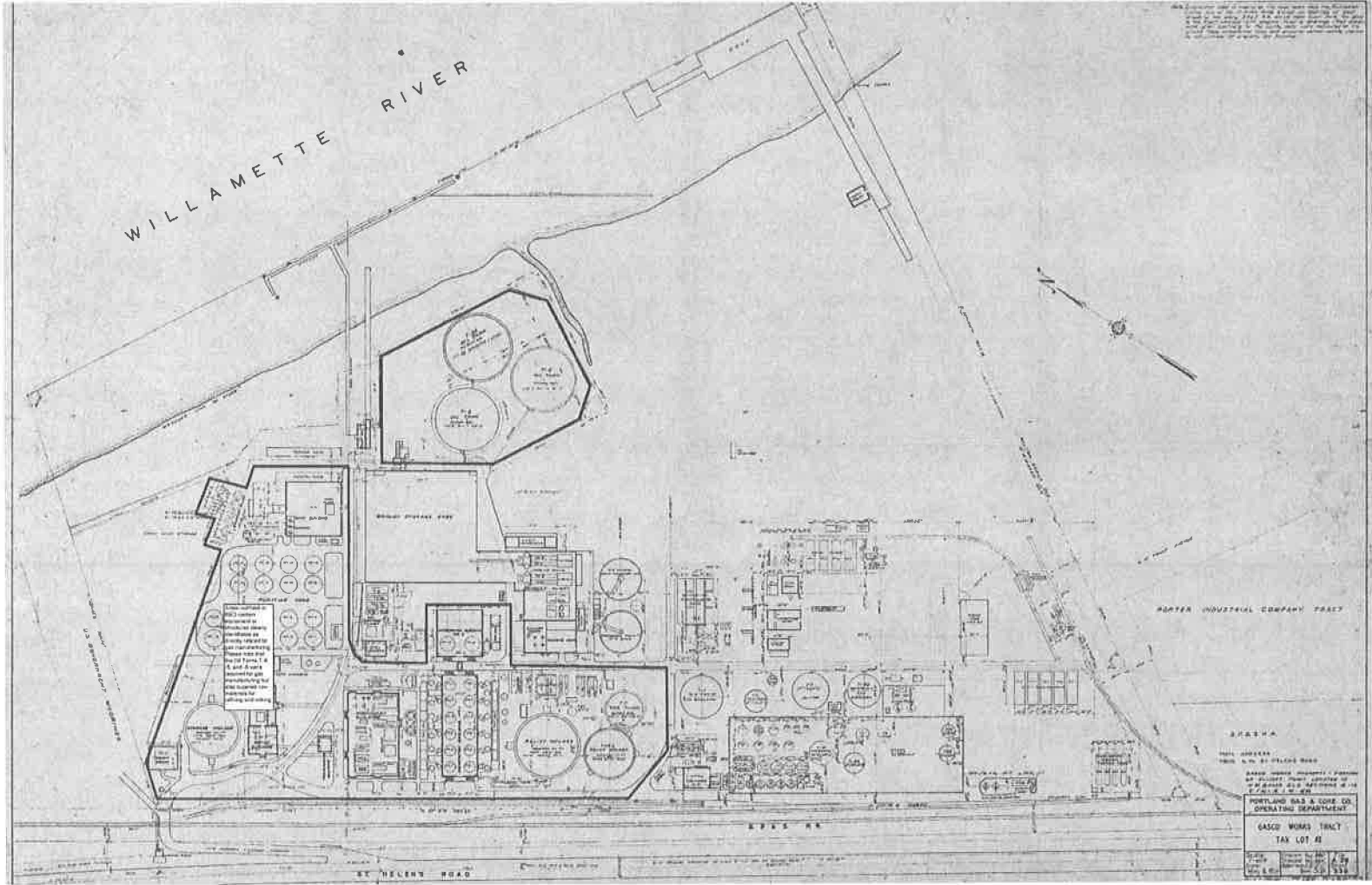


EXHIBIT F



Oregon

John A. Kitzhaber, MD, Governor

Department of Environmental Quality

Northwest Region Portland Office

2020 SW 4th Avenue, Suite 400

Portland, OR 97201-4987

(503) 229-5263

FAX (503) 229-6945

TTY (503) 229-5471

September 4, 2014

Also Sent Via E-mail

Mr. Robert J. Wyatt
NW Natural
220 N.W. Second Avenue
Portland, OR 97209

**Re: Management of Water Treatment System Residuals and Extraction Well PW-2L
Dense Non-Aqueous Phase Liquids - NW Natural "Gasco Site" and the Northern
Portion of the Siltronic Corporation Facility
Portland, Oregon
ECSI Nos. 84 and 183**

Dear Mr. Wyatt:

The Oregon Department of Environmental Quality (DEQ) reviewed the following requests to manage dense non-aqueous phase liquids (DNAPLs) and treatment system residuals:

- "Concurrence Request—Transport and Recycling of an Oil-Water Mixture Collected from Groundwater Wells in the NW Natural Gasco Facility TCE CMMA, 7900 NW St. Helens Rd., Portland, Oregon," dated June 13, 2014 (DNAPL Request), and;
- "Update on NW Natural Source Control Treatment Plant Residuals Sampling Program and Proposed Residuals Characterization and Disposal Protocol" dated July 21, 2014 (received July 23, 2014 [Residuals Determination]) and related correspondence.

NW Natural submitted the first letter to request DEQ's concurrence to transport manufactured gas plant (MGP) DNAPL removed from extraction well PW-2L to an oil processor for reclamation as a fuel. NW Natural submitted the second letter concerning a hazardous waste determination for treatment system residuals; including filter press cake and bag filter solids produced during treatment of groundwater contaminated by MGP constituents, or by MGP constituents and chlorinated volatile organic compounds (cVOCs). The cVOCs in groundwater, including trichloroethene (TCE), cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethene, and vinyl chloride; result from releases on the Siltronic Corporation (Siltronic) Site that DEQ previously determined to be Resource Conservation and Recovery Act (RCRA) F002 listed hazardous waste. The DNAPL removed from extraction well PW-2L and the treatment system residuals are generated on the Siltronic Site and Gasco Site respectively. The letters were prepared on behalf of NW Natural by Anchor QEA, LLC (DNAPL Request) and Aponowich, Driscoll & Associates, Inc. ([ADA] Residuals Determination).

Based on the information provided by NW Natural and after review of DEQ laws and regulations regarding hazardous and solid waste, DEQ has determined the following:

- Groundwater entering the Siltronic pre-treatment facility contains F002 listed hazardous waste and exhibits the toxicity characteristic for benzene.
- Treatment system residuals do not contain and are not F002 hazardous waste. Once NW Natural submits and DEQ reviews and approves documentation of the filter press cake and bag filter solids analytical results, including results showing benzene concentrations are less than the toxicity characteristic hazardous waste criterion, the material can be disposed of as non-hazardous solid waste at Hillsboro Landfill or another DEQ permitted solid waste landfill that is willing to accept the treatment system residuals. The treatment residuals may only be disposed of at a DEQ solid waste permitted landfill and may not be stockpiled or used as daily cover at a landfill disposal site.
- There is insufficient information to approve the DNAPL Request. DEQ requests characterization of the DNAPL to determine if F002 constituents are present. In addition, DEQ will need characterization information about the DNAPL to determine if Oregon's solid waste laws and rules apply to management of the DNAPL. If NW Natural chooses to not provide additional characterization information, then the DNAPL should be managed presumptively as F002 hazardous waste.

Information regarding DEQ's determinations on the regulatory status of DNAPL and the treatment system residuals are provided below.

DNAPL

The DNAPL Request asks for DEQ's concurrence with NW Natural's request to transport MGP DNAPL removed from extraction well PW-2L to used oil processors to be processed into fuel for energy recovery.

After reviewing the DNAPL Request, DEQ cannot agree with NW Natural's request regarding the DNAPL generated from extraction well PW-2L. As indicated above, DEQ determined that releases of cVOCs on the Siltronic Site are F002 listed hazardous waste. Based on previous site characterization work conducted by the two companies, a portion of the Siltronic and NW Natural properties has been designated the "Spent TCE Contaminated Material Management Area" (Spent TCE CMMA). In the Spent TCE CMMA there is the potential for site investigations and cleanup activities to encounter F002 constituents. Extraction well PW-2L is located within the Spent TCE CMMA.

Analysis of DNAPL samples collected from monitoring wells in the vicinity of PW-2L detected cVOCs. For example, TCE was detected in DNAPL samples collected from monitoring well WS-11-125 in concentrations ranging between approximately 15,000 micrograms/kilogram (ug/kg) to 60,000 ug/kg.

Based on the information summarized above, there is the potential for the DNAPL in the Spent TCE CMMA to contain F002 hazardous waste, which would require management as a hazardous waste. Submittal of analyses demonstrating that cVOC constituents are not detected at method detection limits that are less than the lower of DEQ's occupational risk-based concentrations

(RBCs) or universal treatment standards [UTSs]) would provide a basis to rebut the presumption that this waste contains F002. If cVOCs are detected above the lower of the RBCs or UTSs, or if the detection limits exceed these criteria, DEQ would conclude the DNAPL is an F002 listed hazardous waste by the "mixture rule."

In addition to evaluating the DNAPL for F002 constituents, NW Natural should evaluate the potential for the DNAPL to fail characteristic hazardous waste criteria. NW Natural should analyze representative samples using established methodology to determine the potential for DNAPL to fail a hazardous waste characteristic (i.e., toxicity, corrosivity, reactivity, and ignitability). DEQ requests this information to determine whether this waste is hazardous waste, and also to determine whether Oregon's solid waste laws and rules would require specific management of the DNAPL to prevent environmental risks or otherwise meet Oregon's solid waste requirements.

DEQ notes that MGP waste is exempt from the toxicity characteristic (i.e., MGP waste is exempt from testing using the toxicity characteristic leaching procedure [TCLP]). However, DEQ does not extend the MGP TCLP exemption to MGP wastes commingled with non-MGP sources of contamination. For evaluating the toxicity characteristic in these situations, representative samples are collected and analyzed using the TCLP. The results are then compared to the values listed in Table 1 of 40 CFR 261.24.

Depending on the chemical, the detection limits set out in the attachments to the DNAPL Request are greater than RBCs, UTSs, and/or TCLP values. Consequently, this data does not provide information sufficient to answer the question regarding whether the DNAPL is a hazardous waste. The information provided above applies to the DNAPL generated from extraction well PW-2L that is currently stored at the site.

DEQ cannot approve NW Natural's request for long-term management of DNAPL wastes at Thermo-Fluids. DEQ would need to understand the characteristics of the DNAPL waste sufficiently to determine whether Thermo-Fluids can manage and dispose of this type of waste without a DEQ solid waste permit. An important consideration for the long-term approach to managing DNAPL is that cVOC concentrations likely vary between wells and perhaps between sampling periods. NW Natural's proposal for long-term management must include characterizing DNAPL from different locations (e.g., different extraction wells) by collecting a set of samples in accordance with SW-846 methods and using the statistical standards set forth for waste characterization. In the case of DNAPL, DEQ expects that analyses will be difficult given the nature of the material. Consequently, DEQ recommends that NW Natural conduct DNAPL sample collection and analysis using the approach described in DEQ's policy 2004-PO-001, "Guidance on Performing a Hazardous Waste Determination on an Oily Waste," dated June 14, 2004 (attached). Specifically, DEQ has determined that the recommendations for "Managing the material for disposal or in a manner constituting disposal" (which includes burning for energy recovery) apply to the DNAPL generated from within the Spent TCE CMAA.

NW Natural may also choose to presumptively designate and manage DNAPL generated within the Spent TCE CMMA as F002 listed hazardous waste as an alternative approach to characterizing DNAPL as described in the paragraph above. An option that NW Natural may want to consider in this case is to remove the DNAPL to a Subpart B permitted cement kiln or industrial boiler for energy recovery.

TREATMENT SYSTEM RESIDUALS

DEQ has evaluated NW Natural's Residuals Determination which concludes that treatment system residuals are not hazardous waste. DEQ considers the Residuals Determination to be incomplete for the following reasons.

- The letter and supporting data are limited to F002 constituents; and
- The only treatment system analyses that are discussed are the effluent data from the Siltronic and Gasco pre-treatment facilities and only for F002 constituents.

The regulatory status and management of treatment system residuals, including the filter press cake and bag filter solids, is dependent on the influent groundwater being treated. Groundwater influent to the Siltronic pre-treatment system originates within the Spent TCE CMMA. Consequently, there is the potential for the groundwater to contain F002 listed hazardous waste. Given groundwater is an environmental media, detections of cVOCs would trigger a "contained-in determination" for groundwater entering the Siltronic pre-treatment system. Analysis of groundwater influent to the Siltronic pre-treatment system detected cVOCs.

Contained-In Determination

A "contained-in determination" is a process that evaluates whether environmental media exhibit a characteristic of hazardous waste, or are contaminated with concentrations of hazardous substances from listed hazardous waste that are above health-based levels. The determination of whether environmental media contain a listed hazardous waste is based on the risk to human health by direct exposure to the environmental media. Risk-based concentrations for F002 constituents (i.e., TCE, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethene, and vinyl chloride) in groundwater have previously been established for the Spent TCE CMMA as the federal drinking water maximum contaminant levels (MCLs).

Analytical data for groundwater entering and exiting the Siltronic and Gasco pre-treatment facilities were provided via an e-mail sent on June 9, 2014 and supplemented by e-mails sent June 26 and July 7. DEQ concludes from comparing influent cVOC concentrations to MCLs that groundwater entering the Siltronic pre-treatment system contains F002 listed hazardous waste.

There is also the potential for environmental media to contain hazardous substances that fail the toxicity characteristic of hazardous waste based on analysis of representative samples of the media using the TCLP and comparing the results to the values listed in Table 1 of 40 CFR 261.24. In the case of groundwater, detected concentrations of hazardous substances are

compared directly to TCLP values.

As indicated above, DEQ has determined that environmental media impacted by MGP wastes and non-MGP sources of contamination are not exempt from the TCLP. Based on this information, results of analyzing groundwater entering the Siltronic pre-treatment system should be compared to toxicity characteristic hazardous waste values. DEQ concludes based on the benzene concentrations that groundwater entering the Siltronic pre-treatment system is D018 characteristic hazardous waste.

Contained-In Determination Summary and Conclusions

As a generator of a solid waste, NW Natural is required by 40 CFR 262.11 to perform a hazardous waste determination. The influent groundwater contains F002 listed hazardous waste. The next step in the hazardous waste determination process is to determine, for purposes of compliance with 40 CFR Part 268 Land Disposal Restrictions (LDR), whether the influent groundwater exhibits a hazardous waste characteristic. Based upon evaluation of the data provided, DEQ determined that the groundwater is a characteristic hazardous waste, D018 for benzene.

For waste that is both listed and characteristic, 40 CFR 268.9(b) specifies that the standard for the listed waste will operate in lieu of the standard for the characteristic waste provided the listed waste includes a treatment standard for the constituent that causes the waste to exhibit the hazardous waste characteristic. The F002 listed waste LDR prohibition does provide a treatment standard for benzene. Consequently, the pre-treatment system effluent must meet the standards for only F-listed waste and the land disposal restrictions for underlying hazardous constituents associated with the D018 code do not apply.

Status of Treatment System Residuals

The regulatory status and management of treatment system residuals depends on the groundwater being treated. Based on the analytical results for effluent samples collected downstream of where process flows from the Siltronic and Gasco pre-treatment facilities merge, F002 constituents were either not detected above laboratory method detection limits or were detected at concentrations below MCLs. Based on this information DEQ concludes that treatment system residuals meet the treatment standards for F002 wastes and no longer require management as listed hazardous waste. The waste must still be characterized to determine if it is characteristic hazardous waste.

Although the treatment system residuals are not derived from treatment of a listed hazardous waste they are themselves solid wastes and subject to the requirements of 40 CFR 262.11. The treatment system residuals are also considered to be solid waste according to Oregon's statute. Based on the information summarized above, the hazardous waste determination should evaluate whether the treatment system residuals exceed toxicity characteristic criteria. DEQ considers the filter press material and the bag filter solids to be separate waste streams. Hazardous waste

Mr. Robert Wyatt
NW Natural
September 4, 2014
Page 6 of 7

determinations should be performed for both. DEQ also considers the compiled data for F002 constituents, polycyclic aromatic hydrocarbons, and metals provided in ADA's May 15, 2014 letter to be adequate for this purpose. However, the May 15th letter does not provide benzene data which is needed to complete the hazardous waste determinations for the two waste streams.

DEQ requires the laboratory analytical reports for the samples of treatment system residuals, including benzene analyses, to be provided to document the results compiled in the May 15th letter and complete the hazardous waste determinations for the two waste streams. If laboratory analyses for benzene are not available, representative samples of the treatment system residuals should be collected, analyzed for benzene, and the results provided to DEQ.

Pending NW Natural's submittal and DEQ's review and approval of documentation confirming the information in the May 15th letter and that benzene concentrations in filter press cake and bag filter solids are less than the toxicity characteristic hazardous waste criterion, the material can be disposed of as non-hazardous solid waste at Hillsboro Landfill or another DEQ permitted solid waste landfill that is willing to accept the treatment system residuals.

NW Natural should be advised that treatment system residuals are not environmental media. In other words, the materials are not "petroleum contaminated soil." Consequently, the treatment system residuals should be disposed of as solid waste by being placed in the landfill for burial and not stockpiled for other uses in landfill operations or construction, including being used as daily cover.

Please feel free to contact me with questions regarding this letter or the attachment.

Sincerely,

Dana Bayuk
Project Manager
Cleanup and Site Assessment Section

Attachment: DEQ Policy 2004-PO-001

Cc: Patty Dost, Pearl Legal Group
Terry Driscoll, ADA
John Edwards, Anchor
John Renda, Anchor
Carl Stivers, Anchor
Tim Stone, Anchor
Rob Ede, Hahn & Associates
Myron Burr, Siltronic
Alan Gladstone, Davis Rothwell Earle and Xochihua

Mr. Robert Wyatt
NW Natural
September 4, 2014
Page 7 of 7

Bill Earle, Davis Rothwell Earle and Xochihua
James Peale, Maul Foster & Alongi, Inc.
Sean Sheldrake, EPA
Rich Muza, EPA
Lance Peterson, CDM
Scott Coffey, CDM
Keith Johnson, NWR/C&SA
Audrey O'Brien, NWR/SW & HW
Jay Collins, NWR/HW
Tim Spencer, NWR/SW
Rob Burkhart, NWR/WQ
ECSI No. 84 File
ECSI No. 183 File

From: BAYUK Dana <BAYUK.Dana@deq.state.or.us>
Sent: Tuesday, April 14, 2015 4:42 PM
To: Rob Ede
Cc: Bob Wyatt; Patty Dost; Ben Hung; Tim Stone; John Edwards; Carl Stivers; John Renda; Sarah Riddle; Rachel Melissa; Myron Burr; Earle, William G.; Gaekwad, Ilene M.; James Peale; Ben Uhl; JOHNSON Keith; VROOMAN Gary L; COLLINS Jay
Subject: RE: Mgmt of DNAPL Recovered From TCE CMMA

Follow Up Flag: Follow up
Flag Status: Flagged

Good afternoon Rob.

The Department of Environmental Quality (DEQ) reviewed the March 2, 2014 "Mgmt. of DNAPL Recovered From the TCE CMMA" e-mail prepared by Hahn and Associates, Inc. (Hahn) for NW Natural (see below). The e-mail presents the results of analyzing a sample of dense non-aqueous phase liquid (DNAPL) collected from extraction well PW-2L located on the Siltronic Corporation (Siltronic) property.

DEQ's September 4, 2014 letter requested a DNAPL sample be collected and analyzed to support decisions regarding management of DNAPL from extraction well PW-2L. Maul Foster Alongi collected the sample of DNAPL for analysis. The laboratory analytical report is provided as an attachment to Hahn's March 2nd e-mail.

The purpose of this e-mail is to inform NW Natural that DEQ acknowledges:

- NW Natural and Siltronic have conducted additional DNAPL sampling and analysis consistent with our September 4, 2014 letter;
- NW Natural is the generator and is managing the drums of DNAPL as F002-listed hazardous waste based on the analytical results;
- The drums of DNAPL are going to be transported from the Gasco Site to a permitted facility and ultimately used as a fuel supplement in a kiln for the production of cement; and
- NW Natural will manage the DNAPL under its EPA generator identification number for the Gasco Site.

DEQ further acknowledges that in the event NW Natural generates and manages DNAPL from other locations within the TCE CMMA in the future, the process will be the same as indicated above except that additional sampling and analysis will not be conducted. In lieu of collecting and analyzing samples, NW Natural will presume the DNAPL is an F002-listed hazardous waste consistent with the presumptive management option identified in DEQ's September 4th letter.

Please feel free to contact me if you have questions regarding this e-mail.

Mr. Dana Bayuk, Project Manager
NW Region Cleanup & Site Assessment Section Oregon Department of Environmental Quality
2020 SW 4th Avenue, Suite 400
Portland, OR 97201
E-mail: bayuk.dana@deq.state.or.us<mailto:bayuk.dana@deq.state.or.us>
Phone: 503-229-5543
FAX: 503-229-6899

Please visit our website at <http://www.oregon.gov/DEQ/>

P please consider the environment before printing this email

From: Rob Ede [mailto:robe@hahnenv.com]
Sent: Monday, March 02, 2015 11:56 AM
To: BAYUK Dana
Cc: Bob Wyatt; Patty Dost; Ben Hung; Tim Stone; John Edwards; Carl Stivers; John Renda; Sarah Riddle; Rachel Melissa; Myron Burr; James Peale; Ben Uhl
Subject: Mgmt of DNAPL Recovered From TCE CMMA

Dana,

In correspondence dated September 2, 2014, DEQ requested additional testing of manufactured gas plant (MGP) dense non-aqueous phase liquid (DNAPL) recovered from within the trichloroethene (TCE) contaminated media management area (CMMA) at the Siltronic and Gasco properties. As requested by DEQ, the objective of the additional testing is to determine if Resource Conservation and Recovery Act (RCRA) F002-listed hazardous waste constituents are present in the DNAPL. Previous testing did not detect these constituents, but the DEQ letter requested lower laboratory method detection limits (MDLs).

As you and I discussed on February 19, 2015, representatives of Siltronic collected a sample of DNAPL from well PW-2L on January 5, 2015 for analysis of low level VOCs. Siltronic further requested laboratory analyses for gasoline-, diesel-, and oil-range TPH, total metals, TCLP metals, TCLP SVOCs, TCLP VOCs, TCLP Organochlorine pesticides, TCLP chlorinated herbicides, ignitability, corrosivity, total cyanide, sulfide, and specific gravity. A copy of the laboratory report (Specialty Analytical, dated January 21, 2015) is attached.

Based on the results of the testing, which detected low levels of chlorinated VOCs cis-1,2-DCE (9.58 mg/kg) and TCE (3.77 mg/kg), NW Natural believes the oil/water mixture recovered from the TCE CMMA may be a hazardous waste under 40 CFR 261.3(a)(2)(iv) and therefore intends to manage it as an F002 waste.

NW Natural is currently planning to ship 12 drums of DNAPL and water recovered from the TCE CMMA to Green America Recycling, LLC, a RCRA Part B permitted Treatment, Storage, and Disposal (TSD) facility (USEPA ID#: MOD054018288) adjacent to Continental Cement Company, LLC, in Hannibal, Missouri. The F002 listed DNAPL will be used as supplemental fuel within the Continental Cement Company kiln for the production of cement in compliance with RCRA and Clean Air Act permits held by both of these companies.

NW Natural requests DEQ concurrence with the intended classification and disposition for currently stored DNAPL from wells located within the TCE CMMA. We would also appreciate DEQ's agreement that oil/water mixtures recovered from the TCE CMMA going forward may be managed as described in this email.

Best regards,

-Rob

This message may contain confidential and/or privileged information.

If you are not the addressee or authorized to receive this for the addressee, you must not use, copy, disclose, or take any action based upon this message or any information herein. If you receive this message in error, please advise the sender immediately by reply e-mail and delete this message. Thank you.

Rob Ede, R.G. * robe@hahnenv.com<mailto:robe@hahnenv.com>

Hahn and Associates, Inc.

Environmental Consultants

434 NW 6th Avenue, Suite 203

Portland, Oregon 97209-3651

<http://www.hahnenv.com><<http://www.hahnenv.com>/>

Phone: 503.796.0717 * Facsimile: 503.227.2209

EXHIBIT G

Shipyards

Northwest shipbuilding contracts now total in the neighborhood of \$350,000,000. They form part of the exhaustive survey of northwest defense in next Sunday's magazine of The Oregonian.

The Oregonian

U. S. Weather Report

Wednesday temperatures—Maximum, 62 degrees; minimum, 48 degrees.

Forecast—Mostly cloudy, occasional light showers Thursday and Friday. South and southwest wind. Full U. S. weather report on page 13.

OL LXXX--NO. 25,095 Entered at Portland (Oregon) Postoffice as Second-Class Matter. PORTLAND, OREGON, THURSDAY, APRIL 3, 1941 CITY EDITION 28 PAGES PRICE FIVE CENTS

(b)(4) copyright

(b)(4) copyright

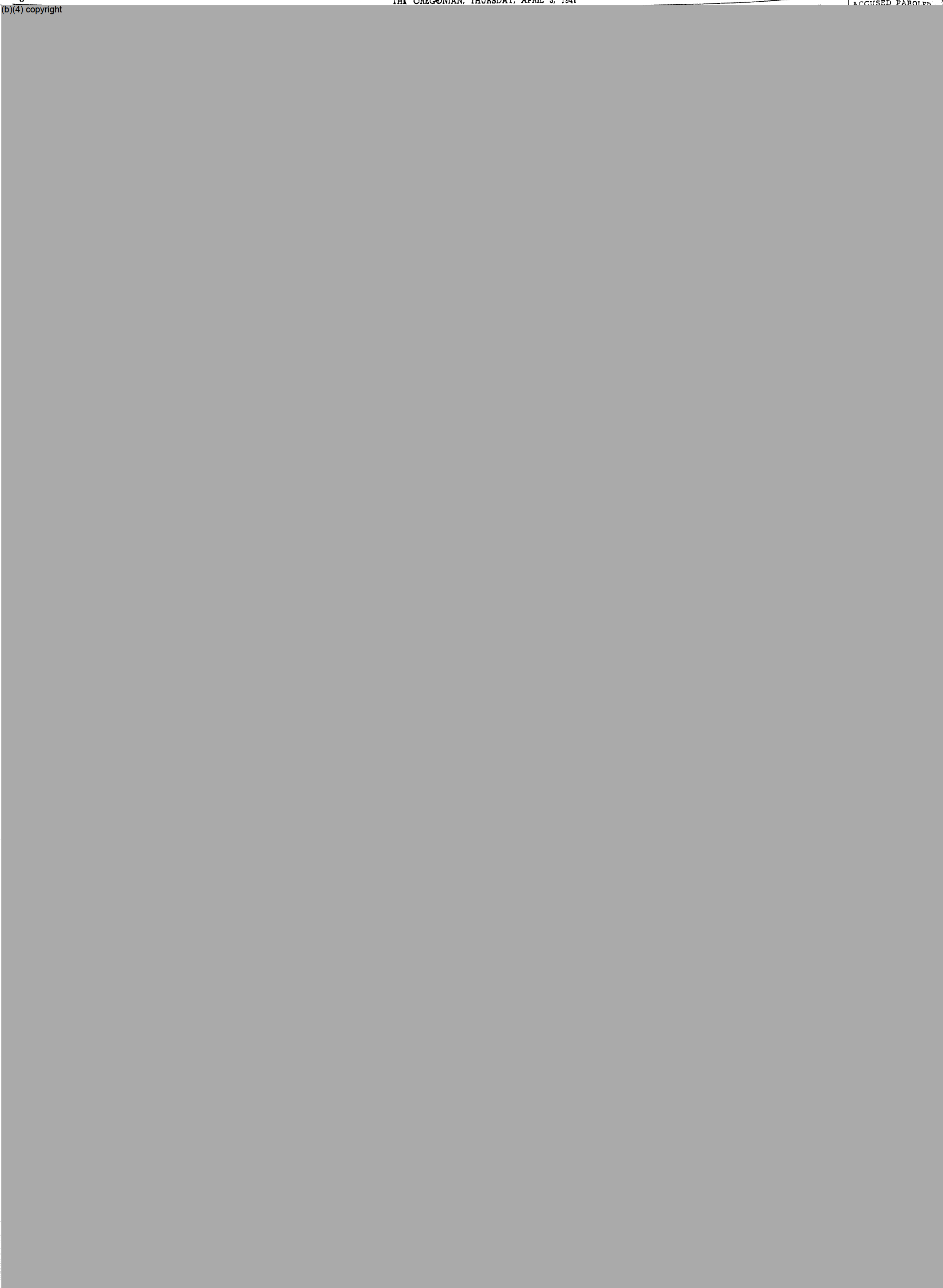


EXHIBIT H

THE SUNDAY OREGONIAN FARM, HOME AND GARDEN, MARCH 18, 1934

(b)(4) copyright

